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Study of Plant Diversity in The Javan Rhino and Conservation Area (JRSCA), Ujung Kulon National Park

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Abstract

The Javan rhinoceros is an endangered animal that is protected according to the Minister of Environment and Forestry No. P.106 of 2018, included in the IUCN Redlist with the category of critically endangered or endangered animals, listed in Appendix I of CITES. In the framework of the conservation of the Javan Rhinoceros, the Javan Rhino and Conservation Area (JRSCA) is planned to be built in the Ujung Kulon national park area. In order to minimize the negative impact on plants in the area, it is necessary to identify the existence of protected and/or rare plant species, as well as the number of trees to be cut down, so this research is necessary. This study aimed to identify the diversity of plants in the JRSCA area that is not being developed and which will be developed, as well as to identify the species of rhinoceros food plants in the JRSCA area. Field data collection in the study of plant diversity in the JRSCA area used the quadratic method using grid lines and interviews. In the undeveloped JRSCA area, 241 plant species were found; the species diversity index ranged from 3.027-3.982 (trees), 2.460-3.573 (poles), 1.177-3.583 (saplings), and 2.421-3.262 (seedlings and understoreys); at various growth stages dominated by 7 species; found 3 species belonging to the VU/Vulnerable category and 1 species belonging to the EN/Endangered category according to IUCN; and found as many as 89 species of rhino food plants. In the area of the JRSCA that will be built, 141 plant species are found; density of 2,221 trees; a total of 2,221 trees planned to be felled with a TBC tree volume of 1,214.06 m^3 and an TT volume of 2,314.08 m^3; and found as many as 1 species including the category VU / Vulnerable according to IUCN.

Keyword: *diversity, plant, JRSCA, national park*

1. Introduction

Ujung Kulon National Park (UKNP) was designated based on the Decree of the Minister of Forestry Number 284/Kpts-II/1992, with the main aim of preserving Javan rhinoceros (Rhinoceros sondaicus, Desmarest 1822). Javan rhinoceros is a rare animal that is included in the IUCN Redlist Data Book in the critically endangered category [1]. The Javan rhino is also listed in CITES Appendix I as an animal that cannot be traded because its numbers are very small, and it is feared that it will become extinct [2]. The Indonesian government has designated the Javan rhino as a protected animal based on Minister of Environment and Forestry Regulation Number P.106 of 2018 [3].

One of the internal factors that threatens the preservation of the Javan Rhino in the UKNP is the degradation of habitat conditions due to the invasion of endangered plants. Considering these conditions, strategic and planned steps need to be taken to save the Javan Rhino population from the threat of extinction. The Indonesian Government, cq. The Ministry of Forestry has established a strategy and action plan for Indonesian Rhino conservation through Minister of Forestry Regulation No. 43/Menhut-II/2007 concerning the Strategy and Action Plan for Indonesian Rhino Conservation for 2007-2017. In the Forestry Ministerial Decree there are 3 (three) short-term plans that need to be implemented for Javan rhino conservation: (1) Increasing the Javan rhino population by 20%, (2) building a second population of Javan Rhino, and (3) Building a Javan rhino sanctuary [4].

Based on the results of the AsRSG (Asian Rhino Specialist Group) meeting on 2-3 March 2009, it was agreed to build the Javan Rhino and Conservation Area (JRSCA) in Ujung Kulon National Park. Furthermore, on June 21, 2010, the Governor of Banten, together with the Minister of Forestry, launched the implementation of the JRSCA development on Peucang Island - UKNP [4].

The Ujung Kulon National Park has created a Javan Rhino Study and Conservation Area (JRSCA), which will become the second habitat for Javan Rhino in the area. Even though the JRSCA development plan has not been included in the 1996-2020 Ujung Kulon National Park Management Plan (UKNPMP), the activities in the JRSCA development program are related to the activities outlined in the 1996-2020 UKNP Management Plan, namely, the conservation of the Javan rhinoceros and handling encroachment [4].

In the JRSCA area, the construction of fences, buildings, and other facilities and infrastructure is planned. It is feared that this will have a negative impact on the existence of plants in the area because the trees will be cut down at the location where they will be built [4]. To minimize the negative impacts caused by plants in the region, the existence of plant species that are protected and/or rare, as well as the number of trees to be cut down, need to be identified. Information on the existence of protected and/or rare plant species as well as the number of trees to be cut down in the JRSCA region will be used as input for the implementation of the development of the JRSCA area to minimize the negative impacts on plants caused by the development of the JRSCA area. However, information related to data on the diversity of plant species in the JRSCA region, which will be built or not, is not yet available; therefore, the study of plant diversity in the JRSCA region needs to be conducted.

This study aimed to identify the diversity of plants in the JRSCA area that is not built and will be built, identify the species of rhino feed plants in the JRSCA area, provide input to the implementing parties for the development of the JRSCA area to minimize the negative impacts on plants resulting from the development of the JRSCA area, and provide input to the JRSCA management so that they can carry out better management.

2. Materials and Methods

2.1. Location and Time of Research

The study was conducted from May to June 2021 in the Javan Rhino Study and Conservation Area (JRSCA), the working area of SPTN II Handeuleum, UKNP Hall, as presented in Error! Reference source not found..

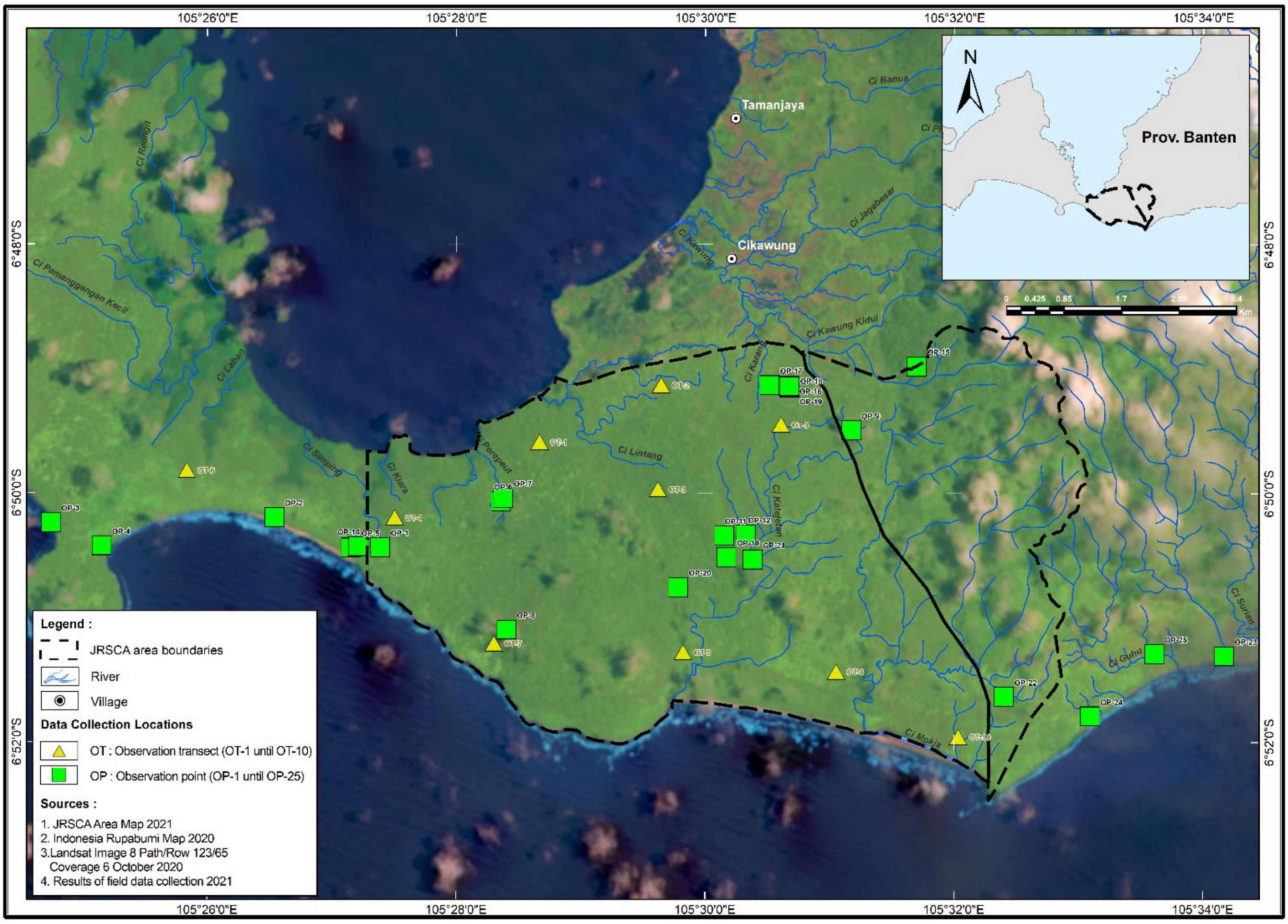


Figure 1. Research location

2.2. Materials and Tools

The materials used in this study were forest stands in the JRSCA - Ujung Kulon National Park, and herbarium manufacturing materials (alcohol, newspaper, transparent plastic bags, and hanging etiquette). The tools used in this study were mines/ropes, compass, meter, phi band (tree diameter measuring device), tree height measuring devices, high levels, global positioning system (GPS), branches, camera scissors, and stationery.

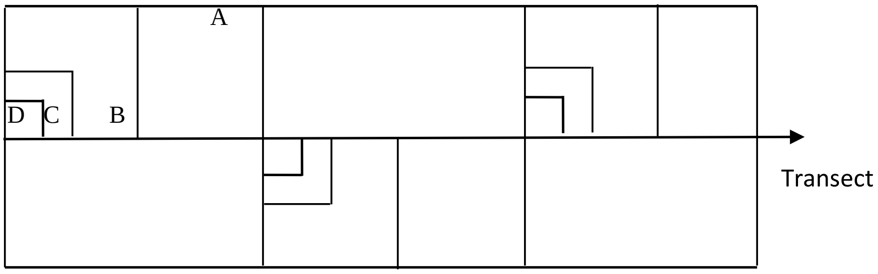
2.3. Data Collection

Data collection in the field uses 2 (two) methods: (1) the quadratic method using plotted lines, and (2) the census method.

2.3.1. Quadratic method in a grid line

Data collection in the field using the quadratic method with grid lines was carried out on 10 observation transects in the JRSCA area that will not be built, with the design presented in **Figure 2** [5].

Ten plots were placed continuously in each transect is 10 plots that are placed continuously. The vegetation conditions that we wanted to know were the structures, vegetation compositions, important value indices, and species diversity indices of each study site.



where :

A = Measurement plot 20 m x 20 m

B = Measurement plot 10 m x 10 m

C = Measurement plot 5 m x 5 m

D = Measurement plot 2 m x 2 m

Figure 2. Scheme of transect placement and measurement plots for vegetation analysis using the lane method

The criteria for the life stage of trees, poles, saplings, and seedlings and the size of the plot follow Soerianegara and Indrawan [6]. Trees, diameter at Breast Height (1.3 m) ≥20 cm, plot size 20 m x 20 m; pole, diameter of chest high (1.3 m) ≥10 cm to <20 cm, plot size 10 m x 10 m; saplings, surfaces that are high >1.5 m to young trees with diameter <10 cm, plot size 5 m x 5 m; seedling, ranging from sprouts to height ≤1.5 m and plants under, plot size 2 m x 2 m. All trees were observed in a large plot of 20 m × 20 m, 10 m × 10 m pole, and 5 m × 5 m, and seedlings and lower plants were observed in 2 m × 2 m plots.

2.3.2. Census method

Data collection in the field using the census method was conducted at 25 observation locations in the JRSCA area that will be built. The vegetation conditions that we want to know are the number of species, structure, number of trees, and tree volume (total height and branch-free height).

2.4. Identification of RTE species (Rare, Threatened, and Endangered)

Protected plant species were identified according to the Regulation of the Ministry of Environment and Forestry No. P.106 of 2018, while for the identification of RTE plant species (Rare, Threatened, and Endangered) classified based on conventions or protection regulations at both international and national levels, namely the CITES Appendix and IUCN.

2.5. Identification of Rhino Feed Plant Species

Identification of rhino feed plant species is performed by cross-checking scientific names and/or photos obtained from the field with scientific names or photos of plants contained in books, journals, and other relevant documents [6–10]. In addition, the identification of rhino feed plant species was carried out through interviews with companions in the field of both Ujung Kulon National Park (UKNP) staff and the community.

2.6. Data Analysis

The collected plant data were then analyzed by calculating the values of species frequency, species density, species domination, important value index, and species diversity using the following formulas [5,11]:

$$Density = \frac{The\ number\ of\ individuals\ of\ a\ species}{Sample\ plot\ area} \quad (1)$$

$$Relative\ Density = \frac{The\ density\ of\ a\ species}{Density\ of\ all\ species}\ x\ 100\% \quad (2)$$

$$Dominance = \frac{Basic\ area\ of\ a\ species}{Sample\ plot\ area} \quad (3)$$

$$Relative\ Dominance = \frac{Dominance\ of\ a\ species}{Dominance\ of\ all\ species}\ x\ 100\% \quad (4)$$

$$Frequency = \frac{The\ number\ of\ plots\ where\ the\ species\ occur}{The\ number\ of\ plots} \quad (5)$$

$$Relative\ Frequency = \frac{Frequency\ of\ a\ species}{Frequency\ of\ all\ species}\ x\ 100\% \quad (6)$$

$$Important\ Value\ Index = Relative\ density + Relative\ frequency + Relative\ dominance\ (poles\ and\ trees) \quad (7)$$

Specifically, for the level of undergrowth, and seedlings and saplings, the importance value index is calculated based on the following formula:

$$Important\ Value\ Index\ (IVI) = Relative\ density + Relative\ frequency \quad (8)$$

The next step was to calculate the Shannon-Wiener diversity index (Shannon Index of Diversity) and the potential for vegetation. The following formula was used to calculate the Shannon-Wiener diversity index [12,13]:

$$Diversity\ (H') = -\Sigma\ [pi \ln pi] \quad (9)$$

$$pi = \frac{ni}{N} \quad (10)$$

where :

H' = *Shannon Index of Diversity*

n_i = The important value index of a species

N = The number of important value indexes of all species

Estimation of tree volume was only carried out at 25 observation locations in the JRSCA area to be built. Estimating tree volume is carried out through 2 (two) stages of activities: calculating the Base Area (BA) and calculating tree volume. The following formula was used to calculate basal area [14]:

$$\mathrm{BA} = 1/4\ \pi d^2 \quad (11)$$

where :

BA = Basal area (m^2)

d = diameter at breast height (1.3 m)

π = Constant value 3.14

The following formula was used to calculate the tree volume [15]:

$$\mathrm{V} = \mathrm{BA\ x\ t\ x\ f}. \quad (12)$$

where :

V = Tree volume (m^3)

BA = Basal area (m^2)

T = Total height/branch free height (m)

f = Form factor (0.7)

3. Results and Discussion

3.1. Results

3.1.1. Plant Diversity in the JRSCA Region That is Not Built

Plant richness

Based on the results of vegetation analysis in 10 transects, as many as 241 species were found. The highest number of species (129) was found in transects near the JRSCA office, while at least 64 species were found at the L3 transect. Plant species data at various growth stages in the 10 transects in the JRSCA region are presented in **Table 1**.

Table 1. Plant species richness at various growth stages in the JRSCA region

No.	Observation location	Number of species				
		Trees	Poles	Saplings	Seedlings and undergrowth	Total
1	Transect of Karangranjang 1 (OT-1)	27	17	29	66	81
2	Transect of Karangranjang 2 (OT-2)	34	23	54	92	115
3	Transect of Karangranjang 3 (OT-3)	43	18	26	69	96
4	Transect near the Pedok 1 (OT-4)	23	16	30	46	81
5	Transect near the JRSCA office (OT-5)	38	48	43	80	129
6	Transect of L3 (OT-6)	37	20	28	35	64
7	Transect of Cilintang (OT-7)	51	36	36	54	92
8	Transect of lane 1 Airmokla (OT-8)	27	22	27	39	68
9	Transect of lane 2 near the fence (OT-9)	42	25	31	40	83
10	Transect of lane 3 Kalajetan (OT-10)	29	22	24	36	69

Species diversity

The highest species diversity at the growth stage of trees and poles was found in the Karangranjang 2 transect, at the growth stage of saplings in transects near the JRSCA office, and at the level of seedlings and lower plants in the Cilintang transect. The lowest species diversity index at the growth stage of trees and poles was found in the Airmokla 1 transect, at the growth stage of the sapling in the Karangranjang 3 transect, and at the growth stage of the seedling and the lower plants in the Karangranjang 1 transect. Data on the diversity of plant species at various growth stages in the 10 transects in the JRSCA area are presented in Table 2.

Table 2. Species diversity index at various growth stages based on the location of the observation transect

No.	Observation location	Diversity Index (H')			
		Seedlings and undergrowth	Saplings	Poles	Trees
1	Transect of Karangranjang 1 (OT-1)	3.538	2.698	1.444	2.421
2	Transect of Karangranjang 2 (OT-2)	3.982	3.573	1.577	2.656
3	Transect of Karangranjang 3 (OT-3)	3.573	2.663	1.177	2.708
4	Transect near the Pedok 1 (OT-4)	3.336	2.968	2.130	2.495
5	Transect near the JRSCA office (OT-5)	3.450	3.086	3.583	2.954
6	Transect of L3 (OT-6)	3.048	2.784	1.396	2.883
7	Transect of Cilintang (OT-7)	3.263	3.157	2.471	3.262
8	Transect of lane 1 Airmokla (OT-8)	3.027	2.460	2.636	2.580
9	Transect of lane 2 near the fence (OT-9)	3.093	3.015	2.764	3.148
10	Transect of lane 3 Kalajetan (OT-10)	3.058	2.537	2.213	2.657

Species dominance

The dominant plant species in 10 transects are as follows: Trees are dominated by *Arenga Obtusifolia* Mart., *Vitex pubescens* Vahl., and *Lagerstroemia flos-reginae* (L) Press.; Poles are dominated by *A. obtusifolia*, *Aporosa aurita* (TUL.) Miq., *L. flos-reginae*, and *Microcos* *tomentosa* J. E. Smith; The saplings are dominated by *Leea sambucina* (L.) Willd., *Trivalvaria macrophylla* (BL.) King, *A. aurita*, *and Barringtonia macrocarpa* Hassk. Blume, *Buchanania arborescens* (BL.) BL., and *Cleistanthus myrianthus* (Hassk.) Kurz, whereas seedlings and undergrowth were dominated by *Apama tomentosa* Willd., *Donax cannaeformis* (G. Frost.) K. Schum., *Ficus montana* Burm. F.; *Daemonorops melanochaetes* Blume; *Diospyros cauliflora* Blume; and *A. obtusifolia*. A list of plant species with the highest IVI in various transects at each growth stage is presented in Table 3.

Table 3. List of plant species with the highest importance value index at various growth stages in various transects

No.	Observation location	Growth stage			
		Seedlings and undergrowth	Saplings	Poles	Trees
1	Transect of Karangranjang 1 (OT-1)	Singadepa (*Apama tomentosa* Willd.)	Sulangkar (*L. sambucina*)	Langkap (*A. obtusifolia*)	Langkap (*A. obtusifolia*)
2	Transect of Karangranjang 2 (OT-2)	Bangban (*D. cannaeformis*)	Sulangkar (*L. sambucina*)	Langkap (*A. obtusifolia*)	Langkap (*A. obtusifolia*)
3	Transect of Karangranjang 3 (OT-3)	Singadepa (*A. tomentosa*)	Kilaja (*T. macrophylla*)	Langkap (*A. obtusifolia*)	Langkap (*A. obtusifolia*)
4	Transect near the Pedok 1 (OT-4)	Amis mata (*F. montana*)	Peuris (*A. aurita*)	Peuris (*A. aurita*)	Laban (*V. pubescens*)
5	Transect near the JRSCA office (OT-5)	Rotan (*D. melanochaeta*)	Songgom (*B. macrocarpa*)	Bungur (*L. flos-reginae*)	Laban (*V. pubescens*)
6	Transect of L3 (OT-6)	Kigentel (*D. cauliflora*)	Kigentel (*D. cauliflora*)	Langkap (*A. obtusifolia*)	Langkap (*A. obtusifolia*)
7	Transect of Cilintang (OT-7)	Langkap (*A. obtusifolia*)	Songgom (*B. macrocarpa*)	Langkap (*A. obtusifolia*)	Langkap (*A. obtusifolia*)
8	Transect of lane 1 Airmokla (OT-8)	Amis mata (*F. montana*)	Ki tanjung (*B. arborescens*)	Daruwak (*M. tomentosa*)	Laban (*V. pubescens*)
9	Transect of lane 2 near the fence (OT-9)	Bangban (*D. cannaeformis*)	Songgom (*B. macrocarpa*)	Bungur (*L. flos-reginae*)	Bungur (*L. flos-reginae*)
10	Transect of lane 3 Kalajetan (OT-10)	Langkap (*A. obtusifolia*)	Kakaduan (*C. myrianthus*)	Langkap (*A. obtusifolia*)	Laban (*V. pubescens*)

Plant species are protected and/or rare

The wealth of plant species found in the JRSCA is not planned to be built for as many as 241 species. Based on its protection status, no protected plant species were found in the region according to Regulation of the Minister of Environment and Forestry (Permen LHK) No. P.106 of 2018 and/or included in the CITES list; however, 84 plant species were found in the IUCN, which were included in the LC/Least Concern category of 80 species, including the VU/Vulnerable category of three species and one plant species including the EN/Endangered category Table 4.

Table 4. List of protected and rare plant species in the unplanned JRSCA region.

No.	Local name	Scientific name	Location	Plant Status			
				Permen LHK P.106	CITES	IUCN	Endemic
1	Kiseu'eur	*Casearia flavovirens* Blume.	3, 7	NP	NL	VU	NE
2	Palahlar	*Dipterocarpus hasseltii* Blume.	9	NP	NL	EN	NE
3	Kibeureum	*Saurauia cauliflora* DC	5	NP	NL	VU	NE
4	Ceunteng	*Thevetia peruviana* (Pers.) Merr.	5	NP	NL	VU	NE

Rhino food plant

Based on the results of the vegetation analysis of the 10 transects, 241 plant species were identified. Of these, 89 were identified as rhinoceros. Data on the number of species and density of rhino-food plants on 10 transects in the JRSCA area are presented in **Table 5**.

Table 5. Number of species and density of Rhino food plants on 10 transects in the JRSCA area.

No.	Observation location	Number of species	Feed density (individual/ha)			
			Seedlings and undergrowth	Saplings	Poles	Trees
1	Transect of Karangranjang 1 (OT-1)	36	35,900	2,384	66	60
2	Transect of Karangranjang 2 (OT-2)	56	43,800	1,056	40	58
3	Transect of Karangranjang 3 (OT-3)	44	27,200	360	20	54
4	Transect near the Pedok 1 (OT-4)	42	40,275	1,560	250	86
5	Transect near the JRSCA office (OT-5)	54	63,800	1,144	92	45
6	Transect of L3 (OT-6)	32	23,050	1,264	34	56
7	Transect of Cilintang (OT-7)	46	19,000	928	152	90
8	Transect of lane 1 Airmokla (OT-8)	34	35,450	2,120	148	125
9	Transect of lane 2 near the fence (OT-9)	43	25,750	768	122	86
10	Transect of lane 3 Kalajetan (OT-10)	37	17,350	1,104	38	130

From Table 5, it can be seen that the highest number of food species was found in the Karang Ranjang 2 transect and the lowest was in the L3 transect. Forage density at the seedling and plant level was highest in the transect near JRSCA and the lowest was in the Kalajetan lane 3 transect; the highest level of saplings was in Karangranjang 1 transect and the lowest was in Karangranjang 3 transect; the highest level of poles was in the transect near pedok 1 and the lowest was in Karangranjang 3 transect, while the highest tree level was in the Kalajetan lane 3 transect, and the lowest was in transect near the JRSCA office. Of the 10 transects observed, the number of transects there were 3 transects, namely Karangranjang 1 transect, Karangranjang 3 transect, and transect near the JRSCA Office.

3.1.2. Plant Diversity in the JRSCA Region to be Built

Plant richness

To determine the richness of plant species in the JRSCA area, where it is planned to be built, this was done through a census. Based on the results of the vegetation census at the pole and tree levels at 25 locations in the JRSCA area, the number of plant species was 141, the density was 2,221, and the total number of trees planned to be felled was 2,221, with an branch-free height (BFH) tree volume of 1,214.06 m^3 and Total Height (TH) volume of 2,314.08 m^3. Data on the number of trees and the volume of trees (branch-free height and total height) planned to be felled in the prospective JRSCA building are presented in Table 6.

Table 6. The number of species, number of trees, and volume of trees (branch-free height and total height) were planned to be felled on prospective buildings in the JRSCA area.

No.	Observation location	Number of species	Number of trees (trees)	Tree volume	
				Branch Free Height (m^3)	Total Height (m^3)
1	Prospective Karangranjang Water Tower Building (OP-1)	7	14	2.22	3.71
2	Prospective for Building Fence 1 Pangukusan (OP-2)	39	282	268.93	411.52
3	Prospective Cibandawoh Water Tower Building (OP-3)	8	14	7.07	10.32
4	Prospective Barracks Building (OP-4)	18	40	17.88	29.18
5	Prospective for Karangranjang Fence 2 Building (OP-5)	30	148	56.34	111.84
6	Prospective of Ciperepat River Dam (OP-6)	1	25	2.24	3.06
7	Prospective of Ciperepat River Water Tower Building (OP-7)	7	11	7.83	1..99
8	Prospective of Bulakan Dam and Water Tower Building (OP-8)	6	7	0.93	1.82
9	Prospective of Building Site L (OP-9)	9	12	25.64	35.96
10	Prospective of Building Site J-1 (OP-10)	3	51	13.84	21.14
11	Prospective of Building Site J-2 (OP-11)	4	69	22.22	31.73

No.	Observation location	Number of species	Number of trees (trees)	Tree volume	
				Branch Free Height (m^3)	Total Height (m^3)
12	Prospective of Building Site J-3 (OP-12)	3	31	7.30	10.83
13	Prospective of water tower building near fence 1 Pangukusan (OP-13)	2	4	2.03	3.22
14	Prospective of water tower building near fence 2 Karangranjang (OP-14)	4	6	3.96	9.64
15	Prospective of Cimahi dam water structure (OP-15)	10	10	46.80	81.62
16	Prospective of Research Shed fence building (OP-16)	65	476	205.41	424.69
17	Prospective of Pedok Development fence building (OP-17)	81	571	434.27	926.48
18	Prospective of Research Laboratory building for the Research Paddock (OP-18)	5	6	3.22	10.97
19	Prospective of building for the Research and Development Laboratory (OP-19)	7	9	5.42	10.01
20	Prospective of building for Research Station 4 (OP-20)	8	258	-	-
21	Prospective for the Kalajetan postal building (OP-21)	2	5	0.39	1.01
22	Prospective of Airmokla fence building (OP-22)	23	172	80.12	163.34
23	Prospective of Rancapinang 1 bridge building (OP-23)	0	0	0.00	0.00
24	Prospective of Rancapinang fence building (Op-24)	0	0	0.00	0.00
25	Prospective of Rancapinang grazing area (OP25)	0	0	0.00	0.00
Total		141	2,221	1,214.06	2,314.08
Average		6	89	48.56	92.56
Maximum		81	571	434.27	926.48
Minimum		0	0	0.00	0.00

From Table 6, it can be seen that the number of trees planned to be felled ranged from 0 to 571 trees, the volume of trees of branch free height ranged from 0.00 – 434.27 m^3 and the volume of trees of total height ranged from 0.00 – 926.48 m^3, with the average number of trees for all locations having 89 trees, the volume of trees of branch free height was 48.56 m^3 and the volume of trees of total height was 92.56 m^3.

Plant species are protected and/or rare

The richness of plant species found in the prospective building area in the JRSCA was 141 species. Based on its protection status, in the prospective building area in the JRSCA area there were no protected plant species found according to the Minister of Environment and Forestry Regulation (Permen LHK) No. P.106 of 2018 and/or included in the CITES List; However, 58 plant species were found that were included in the IUCN, namely 57 species included in the LC/Least Concern category and one species included in the VU/Vulnerable category. A list of protected and/or rare plant species in the prospective building areas of the JRSCA is presented in Table 7.

Table 7. List of protected and/or rare plant species in the prospective building area of JRSCA.

No.	Local name	Scientific name	Location	Plant Status			
				Permen LHK P.106	CITES	IUCN	Endemic
1	Kiseu'eur	*Casearia flavovirens* Blume.	8	NP	NL	VU	NE

Location information: 8 = Prospective of Bulakan Dam and Water Tower Building.

Information on plant status: VU = Vulnerable, EN = Endangered, NE = Non-Endemic, NL = Not Listed, NP = Not Protected.

Impact of infrastructure development in the JRSCA area on flora

Infrastructure development activities planned for the JRSCA include fences, buildings, dams, water towers, and bridges. This infrastructure development aims to support nature conservation, especially the conservation of Javan Rhinoceros. Infrastructure development in the JRSCA area is planned to be conducted in 25 locations with a total area of 8.5 ha, where the area of each infrastructure ranges from 0.01 to 2.54 ha.

Based on the research results, it was shown that the total number of plant species planned to be cut was 141 species or an average of 6 species per location; the total number of trees planned to be felled was 2,221 trees or an average of 89 trees per location; and the total tree volume (branch-free height) was 1,214.06 m^3 or the average for each location was 48.56 m^3 or the total tree volume (total height) was 2,314.08 m^3. Judging from the protection status, in the JRSCA area where infrastructure is planned to be built, there are no plant species that are protected according to Minister of Environment and Forestry Regulation No. P.106 of 2018 and/or included in the CITES List; However, one type of plant was found, which was included in the VU/Vulnerable category according to the IUCN, namely *C. flavovirens*, which was found in the area of the prospective Bulakan Dam and Water Tower Building. One tree *was planned to be cut by C.* flavovirens. Therefore, the negative impact of infrastructure development on flora in the JRSCA area is small, so the negative impact can also be minimized.

3.2. Discussion

3.2.1. Plant Diversity in the JRSCA Region That is Not Built

Plant richness

Species richness is defined as the number of individuals of each species in an area [16]. As shown in Table 1, the total number of plant species in the 10 transects in the undeveloped JRSCA area was 241. The results of this study are higher than those reported by [17], who found 205 species of plants, and by [18], who found 126 species of plants. The differences in species richness found in this study and in previous research were caused by the different numbers of plots and sample areas. The research area in the JRSCA area that will not be built was carried out on 470 plots with a total area of 18.8 ha; while [17] conducted research on 100 plots with a sample area of 4 ha and [18] conducted research on 8 plots with a sample area of 0.16 ha. In connection with this information, it shows that the more plots and sample areas, the more species are found. This is in accordance with Odum [19], who stated that the wider the sample area, the more species found.

In addition, differences in species richness from other studies are also influenced by different environmental factors, such as altitude, soil type, air humidity, and the influence of wind speed and direction. These factors greatly influenced the growth and regeneration processes of plants at the research site. [20] also stated that the diversity of vegetation types in a place is the result of the interaction of several factors, namely: time factors, spatial heterogeneity, competition, predation, environmental stability and productivity of these components.

Based on the number of plant species in each transect in the JRSCA area that was not built, the highest number of plant species was found in the transect near the JRSCA office (129 species), while the lowest was found in the L3 transect (64 species). The high number of plant species in the transect near the JRSCA Office is thought to be because the condition of the secondary forest in the area is still relatively good compared to others and is not invaded by *A. obtusifolia* plant species. The low number of plant species in Transect L3 is thought to be due to the disturbance of the secondary forest in the area due to invasion by the *A. obtusifolia* plant species. *A. obtusifolia* is a species of the Arenga genus and is an invasive species that is not a foreign species but becomes invasive because its growth is uncontrolled and disrupts the existence of other local species. According to Muntasib and Haryanto (1992), as referred to in [21], steppes have very high regeneration potential because they can flower throughout the season. The canopy is quite dense, preventing the penetration of sunlight into the forest floor. This hampers the regeneration of plants that are generally intolerant, as the distribution of a type of plant in a particular community is limited by environmental conditions [22].

Species diversity

Species diversity is a community-level characteristic based on its biological organization. Species diversity was used to express community structure. The diversity of plant species was expressed in the Shannon-Wiener diversity index [23]. According to [23], the diversity index value can range between 0-7, with the criteria: 0-2 (low), 2-3 (medium), and > 3 (high). The plant species diversity index was calculated and categorized for each growth level.

Based on Table 2, it is known that the species diversity index in the growth stage of seedlings and undergrowth in all transects is high; in the sapling growth stage in all transects, it is medium to high; in the mast growth stage in all transects, it is low to high; and in the tree growth stage on all observation transects, it is moderate to high. A community is said to have high species diversity if it is composed of many species. On the other hand, a community is said to have low species diversity if it is composed of few species and if there are only a few dominant species [19].

At the seedling and undergrowth levels, saplings, poles, and trees in the transect near the JRSCA office (OT-5) and transect in lane 2 near the fence (OT-9) had the highest diversity of plant species. This is because these two transects generally have fairly good forest conditions with shade and high tree density compared to other transects, so many species can grow in these locations. One way to determine the level of species diversity is based on the species diversity index [24].

Species dominance

The dominant species are those with high importance [25]. The importance value index (INP) indicates the role of this species in an area. The species with the largest INP indicate that it plays the most important role in that area. This species has the most dominant influence on changes in environmental conditions and the presence of other species in the area [26]. According to Sofyan (1991), as referred to by [27], the species with the highest importance value index among other species are called the dominant species. This reflects the high ability of this species to adapt to the existing environment and compete with other species. According to [28], the importance value shown by each species is an indication that the species in question is considered dominant; that is, it has higher density, frequency, and dominance values than other species.

From Table 3 it can be seen that the plant species in the JRSCA area that were not developed were found to dominate at the tree level, *A. obtusifolia*, *V. pubescens* and *L. flos-reginae*; at the pole level, namely *A. obtusifolia*, *L. flos-reginae*, *M. tomentosa*, and *A. aurita*; at the sapling level, namely *B. macrocarpa*, *L. sambucina*, *T. macrophylla*, *A. aurita*, *D. cauliflora*, *B. arborescens*, and *C. myrianthus*; and at the seedling and undergrowth level, namely *F. montana*, *D. cannaeformis*, *A. obtusifolia*, *A. tomentosa*, *D. cauliflora*, and *D. melanochaeta*. Species of plants such as *A. obtusifolia*, *V. pubescens*, *L. flos-reginae*, *M. tomentosa*, *A. aurita*, *B. macrocarpa*, *L. sambucina*, *C. myrianthus*, *B. arborescens*, *D. cauliflora*, *T. macrophylla*, *F. montana*, *D. cannaeformis*, *A. tomentosa*, and *D. melanochaeta* whose abundant presence means these plants will survive for a long time. The higher the INP value of a plant species, the greater its role in the plant community [29]. In addition, low vegetation levels can reduce ecosystem resilience [30].

Plant species that dominate forest areas will have a higher Importance Value Index (INP) than other species, so that the dominant species in a community or ecosystem will play a role in controlling ecological processes in their habitat. Ecological processes that occur in a forest community or ecosystem include climate change, reciprocal relationships, competition between species, parasitism, and commensalism [31]. Variations in species diversity in a region commonly experience different conditions. This is influenced by soil type, growing location, rainfall, temperature, and competition for nutrients at that location [32].

Plant species are protected and/or rare

Based on Table 4, it shows that in the JRSCA area that was not built, four species of rare plants were found, namely *C. flavovirens*, *D. hasseltii*, *S. cauliflora*, and *T. peruviana*. The results of this study were lower than the number of rare plant species found in the UKNP. According to [33], approximately 57 species of rare plants are found at UKNP.

Rhino food plant

As shown in Table 5, the number of species of rhinofood plants found in the undeveloped JRSCA area was 89. The results of this study are lower than the research of [34] and Schenkel and [35] which found as many as 150 species, [36] and [37] who found 159 species, [38] who found 190 species, [39] and Muntasib et al. (1993) referred to in [40] who found 251 species, and [41] who found 184 species. The low number of species of rhinoceros food at the research location is thought to be due to the smaller number of plots and the smaller sample plot area compared to previous studies, such that the number of plant species found at the location, including the species of plants that rhinos feed on, is lower. This is in accordance with [19], who stated that the wider the sample area, the more species found.

3.2.2. Plant Diversity in the JRSCA Region to be Built

Plant richness

Based on Table 6, the number of plant species found at the 25 observation locations in the JRSCA area that will be built ranges from 0 to 81 species, density ranges from 0 to 571 trees, tree volume (branch free height) is 0 to 434.27 m^3 and tree volume (total height) is 0 to 926.48 m3. The differences in the number of tree species and density at the 25 observation locations were caused by two factors: the size of the sample area and the presence of invasive plant species. The area of each research location in the JRSCA that will be built ranges from 0.01 to 2.54 ha. In general, the number of species, tree density, and tree volume will be higher with a wider sample area of the research location. This is in accordance with [19], who stated that the wider the sample area, the more species found. As more species are found, the density and volume of trees at the research location will also increase. In addition, the high and low number of species, density, and volume of trees at each research location were also influenced by the presence of *A. obtusifolia*. The presence of *A. obtusifolia* species in the research area will have an impact on inhibiting the regeneration of plants other than *A. obtusifolia* in the research location, resulting in a lower number, density, and volume of tree species. According to Muntasib and Haryanto (1992) as referred to in [21], *A. obtusifolia* has very high regeneration potential because it can flower throughout the season and the canopy is dense enough to inhibit the penetration of sunlight to the forest floor. This hampers the regeneration of plants that are generally intolerant, as the distribution of plant species in a particular community is limited by environmental conditions [22].

Tree volume is the mass of wood from a tree to a certain height and stemp diameter. These three volume values are listed in Table 6. This study shows that research locations that were not invaded by *A. obtusifolia* had higher tree volumes than research locations that were invaded by *A. obtusifolia*. This indicates that tree species that have survived until the climax succession process have reached this diameter class, even up to >60 cm in diameter, at the research location that was not invaded by *A. obtusifolia*. According to [42], diameter is a characteristic that is easy to measure and has a strong correlation with other important parameters, such as the basal area (BA) and stem volume.

Plant species are protected and/or rare

Table 7 shows that in the JRSCA area that will be built, one species of rare plant was found, namely *C. flavovirens*. The results of this study are lower than the number of rare plant species found in TNUK. According to [33], approximately 57 species of rare plants are found at UKNP.

Impact of infrastructure development in the JRSCA area on flora

Referring to the Regulation of the Minister of the Environment of the Republic of Indonesia, Number 16 of 2012 [42], the environmental components significantly impacted by business plans and/or activities include four components: geo-physical-chemical, biological, socioeconomic-cultural, and community health. One of the biological components is the vegetation/flora and the presence of rare and/or endemic species and their habitats. According to the Ujung Kulon National Park Center and the Faculty of Forestry and Environment IPB [4], the potential impact of development in the JRSCA area on biological components, especially flora, is the effect on the number of species, density of flora, volume of trees, and endemic, protected, and/or rare flora.

As explained previously, the infrastructure development activities planned for the JRSCA area include fences, buildings, dams, water towers, and bridges, which aim to support nature conservation, especially the conservation of Javan Rhinoceros. Infrastructure development in The JRSCA plant species planned to be carried out at 25 locations ranging from 0.01 to 2.54 ha, the number of trees planned to be felled ranges from 0 to 81 species, the number of trees planned to be felled ranges from 0 to 571 trees, the volume of trees (branch-free height) ranges from 0 to 434.27 m3 and tree volume (total height) ranges from 0 to 926.48 m3, as well as one species of rare plant planned, namely *C. flavovirens*. By looking at the small area to be built, the number of species and number of trees to be cut down is small, and only one type of rare plant will be cut down; it can be stated that the negative impact of infrastructure development on flora is small, so that the negative impact can also be minimized. According to the Ujung Kulon National Park Center and Faculty of Forestry and Environment IPB [4], the results of the evaluation of the construction of fences, buildings, dams, water towers, and bridges in the JRSCA area have no impact on flora and are considered feasible from an environmental perspective.

4. Conclusions

In the undeveloped JRSCA area, 241 plant species were found; species diversity index ranges from 3.027 – 3.982 (trees), 2.460 – 3.573 (poles), 1.177 – 3.583 (saplings), and 2.421 – 3.262 (seedlings and undergrowth); at various growth stages dominated by species including Amis mata (*F. montana*), Bangban (*D. cannaeformis*), Langkap (*A. obtusifolia*), Songgom (*B. macrocarpa*), Sulangkar (*L. sambucina*), Bungur (*L. flos-reginae*), and Laban (*V. pubescens*); 3 species were found that were in the VU/Vulnerable category and 1 plant species was in the EN/Endangered category according to the IUCN; and found as many as 89 species of plants that rhinos feed on.

In the JRSCA area that will be built, 141 plant species were found; the density of 2,221 trees; the total number of trees planned to be felled was 2,221, with a Branch Free Height (BFH) tree volume of 1,214.06 m^3 and a Total Height (TH) volume of 2,314.08 m^3; and one species was found in the VU/Vulnerable category according to the IUCN.

The area to be built is relatively small, the number of species and number of trees to be felled is small, and only one species of rare plant will be felled. Thus, it can be stated that the negative impact of infrastructure development on flora is small, so that the negative impact can be minimized. Therefore, the results of this research can be used as a reference to minimize the negative impact of infrastructure development in the JRSCA area on flora.

Author Contributions

S: Conceptualization, Acquisition of data, Analysis of data, Writing - Review & Editing; **H:** Conceptualization, Review & Editing; **EHM:** Conceptualization, Review & Editing**.**

Conflicts of interest

There are no conflicts to declare.

References

1. IUCN. 2023. IUCN Red List of Threatened Species. Retrieved on date 21 Juli 2023 dari www.redlist.org.
2. CITES. 2023. Protected Species. <www.cites.org>. Retrieved on date 21 Juli 2023.

3. Kementerian Lingkungan Hidup dan Kehutanan. 2018. Peraturan Menteri Kehutanan dan Lingkungan Hidup No. P.106 Tahun 2018 tentang Satwa dan Tumbuhan yang Dilindungi.
4. Balai Taman Nasional Ujung Kulon (Balai TNUK)- Fakultas Kehutanan dan Lingkungan IPB. 2021. Laporan Akhir Feasibility *Study Javan Rhino and Conservation Area* (JRSCA) Taman Nasional Ujung Kulon. Balai Taman Nasional Ujung Kulon (Balai TNUK)- Fakultas Kehutanan dan Lingkungan IPB.
5. Soerianegara, I; Indrawan, A. Ekologi hutan Indonesia. Institut Pertanian Bogor: Bogor, Indonesia, 2008.
6. Heyne, K. Tumbuhan berguna Indonesia. Terjemahan. Yayasan Sarana Wana Jaya: Jakarta, Indonesia, 1987.
7. PROSEA. Plant Resources of South-East Asia 2: Edible Fruits and Nuts (Editors: E.W.M. Verheij and R.E. Coronel). PROSEA Foundation: Bogor, Indonesia, 1992.
8. ________. Plant Resources of South-East Asia 3: Dye and Tannin-Producing Plants (Editors: R.H.J.M. Lemmens and N. Wulijarni-Soetjipto). PROSEA Foundation: Bogor, Indonesia, 1992.
9. ________. Plant Resources of South-East Asia 5:(1) Timber Trees: Major Commercial Timbers (Editors: I. Soerianegara and R.H.M.J. Lemmens). PROSEA Foundation: Bogor, Indonesia, 1994.
10. ________. Plant Resources of South-East Asia 12: (1) Medicinal and Poisonous Plants 1 (Editors: L.S. de Padua, N. Bunyapraphatsara and R.H.M.J. Lemmens). PROSEA Foundation: Bogor, Indonesia, 1999.
11. Kusmana, C. *Metode Survei Vegetasi*. IPB Press: Bogor, Indonesia, 1997.
12. Pielou, E.C. *An Introduction to Mathematical Ecology*. John Wiley and Sons, New York, NY, USA, 1969.
13. Magurran, A.E. Ecological Diversity and Its Measurement. Princeton University Press: New Jersey, NJ, USA, 1988.
14. Simon, H. Metode Inventore Hutan. Aditya Media: Yogyakarta, Indonesia, 1996.
15. Djuwadi. Pengusahaan Hutan Rakyat. Fakultas Kehutanan Universitas Gadjah Mada: Yogyakarta, Indonesia, 2002.
16. Hidayat, M. Analisis vegetasi dan keanekaragaman tumbuhan di Kawasan Manifestasi Geotermal Ie Suum Kecamatan Raya Kabupaten Aceh Besar. *Jurnal Biotik.* **2017**, *5,* 114-124.
17. Febriana, I.; Kusmana, C.; Rahmat, U.M. Komposisi jenis tumbuhan dan analisis sebaran langkap (*Arenga obtusifolia* Mart.) di Taman Nasional Ujung Kulon. *Journal of Natural Resources and Environmental Management*. **2019**, *10*, 52-65.
18. Mahmud, R.; Kartono, A.P.; Prasetyo, L.B. Preferensi relung pakan badak jawa dan banteng. *Media Konservasi.* **2020**, *25,* 81-88.
19. Odum, E.P. *Dasar-Dasar Ekologi.* Gadjah Mada University Press: Yogyakarta, Indonesia, 1993.
20. Krebs, C. J. Ecological Methodology. Harper and Row Publisher: New York, NY, USA, 1978.
21. Haryanto; Siswoyo. Sifat-sifat morfologis dan anatomis lanskap. *Media Konservasi*. **1997**, 105 -109.
22. Gunawan, W.; Basuni, S.; Indrawan, A.; Prasetyo, L.B.; Soedjito, H. Analisis komposisi dan struktur vegetasi terhadap upaya restorasi kawasan hutan Taman Nasional Gunung Gede Pangrango. *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan*. **2011**, *1,* 93-105.
23. Barbour, M.G.; Burk, J.H.; Pitts, W.D. Methods of Sampling the Plant Community. In: Barbour, M.G.; Burk, J.H.; Pitts, W.D; Eds., Terrestrial Plant Ecology, 2nd Edition, Benjamin/Cummings Pub. Co.: California, CA, USA, 1987.
24. Istomo; Sari, P.N. Penyebaran dan karakteristik habitat jenis rasamala (*Altingia excelsa* Noronha) di Taman Nasional Gunung Halimun Salak. *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan.* **2018**, *9*, 608-625.
25. Susilo, A. Asosiasi jenis-jenis pohon dominan di Cagar Alam Gunung Tilu. *814 Proceeding Biology Education Conference*. **2018,** *15*, 813-817.
26. Abdiyani, S. Keanekaragaman jenis tumbuhan bawah berkhasiat obat di Dataran Tinggi Dieng. *Jurnal Penelitian Hutan dan Konservasi Alam*. **2008**, *1*, 7992.
27. Destaranti, N.; Sulistyani; Yani, E. Struktur dan vegetasi tumbuhan bawah pada tegakan pinus di RPH Kalirajut dan RPH Baturraden Banyumas. *Scripta Biologica*. **2017,** *4*, 160-166.
28. Taati, L. Analisis komposisi dan potensi hutan produksi di Wilayah Kesatuan Pengelolaan Hutan (KPH) Dampelas Tinombo Kecamatan Dampelas Kabupaten Donggala. *Jurnal Katalogis*. **2015**, *3,* 203-216
29. Kainde, R.P. Analisis vegetasi hutan lindung Gunung Tumpa. *Eugenia*. **2011**, 17, 1–11.
30. Alima, N.; Edo, C.N.; Elsa, W.R.; Afifah, I.; Elisa, F.I. Analisis vegetasi di sekitar area bunker kawasan Taman Nasional Gunung Merapi. *Bioma*. **2020**, *22*, 110-114.

31. Panjaitan, B.U.; Asmarahman, C. Analisis keanekaragaman jenis pohon pada Hutan Kota Metro. *Jurnal Rimba Lestari*. **2021**, *1*, 124-131.
32. Indriyanto. Metode Analisis Vegetasi dan Komunitas Hewan. Buku. Graha Ilmu: Yogyakarta, Indonesia, 2008.
33. Handayani, U.; Idris, M.H.; Aji, I.M.L. Keragaman vegetasi berdasarkan tipe pengelolaan lahan pada hutan produksi di Desa Banyu Urip Kabupaten Lombok Tengah. *Jurnal Silva Samalas.* **2022**, *5*, 1-11.
34. Abdurrachman; Pratiwi, A. Pengelolaan Taman Nasional Ujung Kulon (TNUK). *Journal of Indonesian Tourism and Policy Studies.* **2017**, *2,* 6.
35. Hoogerwerf, A. Udjung Kulon the Land of The Last Javan Rhinoceros. E.J. Brill: Leiden, 1980.
36. Schenkel, R.; Schenkel, L. Situation of The Javan Rhino in Ujung Kulon National Park. Assessment in March 1982. After The Deatf of Five Rhinos. WWF/IUCN Gland Switzerland, 1982.
37. Djaja, B.; Sadjudin, H.R.; Khian, L.Y. Studi Vegetasi untuk Keperluan Makanan bagi Badak Jawa (*Rhinoceros sondaicus* Desmarest). Special Report No. 1 IUCN/WWF Project No. 1960. Fakultas Biologi UNAS: Jakarta, Indonesia, 1982.
38. Sadjudin. Status and Distribution of The Javan Rhino (*Rhinoceros sondaicus* Desmarest 1982) in Ujung Kulon National Park. Paper Presented in Large Mammals Workshop in Chitawan National Park, Nepal. Januari 29 to February 8, 1990.
39. Amman, H. Contribution to The Ecology and Sociology of The Javan Rhinoceros (*Rhinoceros sondaicus* Desm.). Inaugural dissertation. Philosophisch-Naturwissenschaftlichen Fakultat der Universitat Basel. Econom-Druck AG, Basel, 1985.
40. Hommel, W.F.M.P. Landscape Ecology of Ujung Kulon (West Java, Indonesia). Privately Published, 1987.
41. Mas'ud, B.; Prayitno, W. Analisis potensi dan manajemen tumbuhan pakan badak jawa. *Media Konservasi*. **1997**, 49 -66.
42. Rahmat, U.M.; Santosa, Y.; Kartono, A.P. Analisis Preferensi Habitat Badak Jawa (*Rhinoceros sondaicus*, Desmarest 1822) di Taman Nasional Ujung Kulon. *JMHT*. **2008**, *14*, 115-124.
43. Herianto. Keanekaragaman jenis dan struktur tegakan di areal tegakan tinggal. *Jurnal Daun*. **2017**, *4,* 38–46.
44. Peraturan Menteri Negara Lingkungan Hidup Republik Indonesia, Nomor 16 Tahun 2012. 2012.